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(54) Title of the Invention:

ORGANIC LIGHT EMITTING ELEMENT, AND APPARATUS AND METHOD FOR MANUFACTURING THE SAME

(57) Abstract:

[Problem] To provide an apparatus and method of manufacturing an organic light emitting element, capable of forming an evaporation layer on a substrate without displacement of the deposition position and variation of deposition area at a high deposition rate, keeping the uniformity of thickness of the film to be miniaturized and manufactured at low cost.

[Means for Resolution] A shielding plate 12 is provided in a chamber 11 to be partitioned into an upper space and a lower space. An oblong evaporation window 13 is formed in the shielding plate 12. An evaporation source 16 is disposed opposite to the evaporation window 13 below the shielding plate

12. A moving mechanism 17 for moving the substrate 1 with respect to the evaporation window 13 is provided on the shielding plate 12. A metal mask 20 is fitted to the lower surface of the substrate 1 adjacent to the substrate 1 at need.

[Claims]

1. A manufacturing apparatus for an organic light emitting element, which is a manufacturing apparatus for forming at least an organic material layer of an organic light emitting element where a first electrode, the organic material layer and a second electrode are stacked on a substrate by an evaporation method, characterized in that on one surface side of a shielding member having an opening part, an evaporation source is disposed in a position opposite to the opening part, and a moving mechanism for moving the substrate in a first direction relatively to the opening part is provided on the other side of the shielding member.

2. The manufacturing apparatus for an organic light emitting element according to claim 1, wherein the evaporation source has a width equal to or larger than the width of an evaporation region on the substrate in a second direction intersecting perpendicularly to the first direction.

3. The manufacturing apparatus for an organic light emitting element according to claim 2, wherein the evaporation source is integrally provided in an area having a width equal

to or larger than the width of the evaporation region on the substrate in the second direction.

4. The manufacturing apparatus for an organic light emitting element according to claim 2, wherein the evaporation source is dispersively provided in an area having a width equal to or larger than the evaporation region on the substrate in the second direction.

5. The manufacturing apparatus for an organic light emitting element according to one of claims 1 to 4, wherein the opening part of the shielding member has a width equal to or larger than the width of the evaporation region on the substrate in the second direction intersecting perpendicularly to the first direction.

6. A manufacturing method for an organic light emitting element, which is a manufacturing method for forming at least an organic material layer of an organic light emitting element where a first electrode, the organic material layer and a second electrode are stacked on a substrate by an evaporation method, characterized in that while on one surface side of a shielding member having an opening part, evaporation material is evaporated from an evaporation source disposed in a position opposite to the opening part, the substrate is moved in a first direction relatively to the opening part on the other surface side of the shielding member to thereby form an evaporation layer on the substrate.

7. The manufacturing method for an organic light emitting element according to claim 6, wherein the width of the evaporation source in a second direction intersecting perpendicularly to the first direction is set equal to or larger than the width of an evaporation region on the substrate.

8. The manufacturing method for an organic light emitting element according to claim 6 or 7, wherein the width of the opening part of the shielding member in the second direction intersecting perpendicularly to the first direction is set equal to or larger than the width of an evaporation region on the substrate.

9. An organic light emitting element, characterized in that a first electrode, an organic material layer and a second electrode are stacked on a substrate, and the organic material layer is formed by evaporating organic material on one surface side of a shielding member having an opening part from an evaporation source disposed in a position opposite to the opening part and simultaneously moving the substrate relatively to the opening part on the other surface side of the shielding member.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Belongs]

This invention relates to an organic light emitting element having a light emitting layer formed of organic material

such as an organic electroluminescence element or the like, its manufacturing apparatus and its manufacturing method.

[0002]

[Prior Art]

In recent years the demand for a plane display element having lower power consumption and smaller capacity as compared with a generally used CRT (cathode ray tube) has grown with diversification of the information device. As one of such plane display elements, an electroluminescenc element (hereinafter referred to as EL element) has been watched. Such EL elements are classified roughly into an inorganic EL element having a light emitting layer formed of inorganic material and an organic EL element having a light emitting layer formed of organic material.

[0003]

In the inorganic EL element, generally a high electric field is applied to a light emitting part, and electrons are accelerated in the high electric field to collide with the center of light emission, thereby exciting the center of light emission to emit light. On the other hand, in the organic EL element, electrons and Halls are respectively injected from an electron injection electrode and a Hall injection electrode into a light emitting part, the electrons and Halls are recombined in the center of light emission to put the organic molecules in the excited state, and when the organic molecules return to the

ground state from the excited state, fluorescence is generated. Such an organic EL element has a structure in which one or more light emitting elements are disposed in a matrix on a substrate.

[0004]

While high voltage as much as 100V to 200V is needed as driving voltage because the inorganic EL element requires a high electric field, the organic EL element has the advantage that it can be driven with low voltage as much as 5V to 20V.

[0005]

In the case of the organic EL element, phosphor, which is luminescent material, is selected to obtain a light emitting element adapted to emit light in a suitable color, so it can be expected to be used as a multi-color or full-color display device. Further, since the organic EL element can perform surface light emission with low voltage, it can be used as a backlight for a display device such as a liquid crystal display device.

[0006]

In order to use the organic EL element of this type as a display device, it is essential to attain high integration, high resolution and full coloration of the light emitting elements on the substrate.

[0007]

In order to attain high integration and high resolution of the organic EL element, bulkhead separation technology called

" ribbing " has been introduced, in which integration can be performed by narrowing the space between the light emitting elements on the substrate.

[0008]

Figs. 9 and 10 are sectional views of processes showing a manufacturing method for an organic EL element. On a substrate 31 of a glass substrate or the like shown in Fig. 9A, a transparent conductive film formed of ITO (indium•tin oxide) is formed as shown in Fig. 9B, and a Hall injection electrode 32 is formed by patterning the transparent conductive film.

[0009]

Subsequently, as shown in 9C, a first insulating layer 33 is formed on the substrate 31 and the patterned Hall injection electrode 32. Subsequently, as shown in Fig. 9D, a second insulating layer 34 having a larger thickness as compared with the first insulating layer 33 is formed as a rib on the first insulating layer 33. Thus, a high step is formed.

[0010]

Subsequently, as shown in Fig. 10E, an organic light emitting layer 35 made of organic light emitting material is formed on the Hall injection electrode 32, the first insulating layer 33 and the second insulating layer 34 by an evaporation method. Further, as shown in Fig. 10F, an electron injection electrode 36 is formed on the organic light emitting layer 35. Thus, one or more light emitting elements are formed on the

substrate 31.

[0011]

In this case, the second insulating layer 34 has a enough larger thickness as compared with the organic light emitting layer 35 and the electron injection electrode 36, so that a breakage (stepped cut) of the organic light emitting layer 35 and the electron injection electrode 36 is caused at the step part of the second insulating layer 34 so as to separate the light emitting elements from each other.

[0012]

Lastly, as shown in Fig. 10G, the one or more light emitting elements formed on the substrate 31 are sealed with a sealing compound 37.

[0013]

In a monochromatic organic EL element, the one or more light emitting elements on the substrate 31 can be thus separated with the first insulating layer 33 and the second insulating layer 34.

[0014]

In order to perform full coloration, however, it is necessary to form different light emitting elements respectively emitting red, green and blue on the substrate. In this case, it is necessary to evaporate different organic light emitting materials on the adjacent light emitting elements, respectively. Therefore, separately application of an organic

light emitting material using a metal mask needs to be used jointly with the above bulkhead separation technology.

[0015]

[Problems that the Invention is to Solve]

Fig. 11 is a typical sectional view showing the conventional manufacturing device for an organic light emitting element. The manufacturing apparatus of Fig. 11 is used in evaporation of an organic light emitting layer of an organic EL element or the like.

[0016]

In Fig. 11, a substrate 31 is disposed in a chamber 101, and an evaporation source 102 is disposed below the central part of the substrate 31. The evaporation source 102 is constructed by evaporation material and a heating holder for heating the evaporation material. Fig. 11 shows the case of disposing the evaporation source 102 in a position P1 near the substrate 31 and the case of disposing the evaporation source 102 in a position P2 away from the substrate 31.

[0017]

The evaporation material isotropically scatters from the evaporation source 102 round the centerline L1 of the evaporation source 102. In the case where the evaporation source 102 is disposed in the position P1 near the substrate 31, the deposition rate on the substrate 31 is increased. However, there is a large difference between the distance from the evaporation

source 102 to the central part of the substrate 31 and the distance from the evaporation source 102 to the end part of the substrate 31, which easily causes a variation in film thickness of an organic light emitting layer formed on the substrate 31. That is, there is the possibility of lowering the uniformity of film thickness in the substrate 31.

[0018]

On the other hand, in the case where the evaporation source 102 is disposed in the position P2 away from the substrate 31, the difference between the distance from the evaporation source 102 to the substrate 31 and the distance from the evaporation source 102 to the end part of the substrate 31 is decreased so that the uniformity of film thickness of the organic light emitting layer formed on the substrate 31 can be secured to some degree. The distance from the evaporation source 102 to the substrate 31 is, however, increased so as to decrease the deposition rate on the substrate 31. As a result, throughput in mass production is lowered, and then the equipment cost is increased with increase in size of the manufacturing apparatus.

[0019]

Fig. 12 is a diagram showing the position relationship of an evaporation source, a substrate and a metal mask in the case of separately applying organic light emitting materials in a full-color organic EL element.

[0020]

As shown in Fig. 12, in the case of coating with different organic light emitting materials, a metal mask 20 is mounted adjacent to the substrate 31. The metal mask 20 has an opening part with a width W.

[0021]

In the vicinity of the central part of the substrate 31, evaporation material scattered from the evaporation source 102 enters the substrate 31 substantially vertically through the opening part of the metal mask 20, so that the evaporation material is evaporated in a position substantially corresponding to the opening part of the metal mask 20, and the width W1 of the evaporated region is substantially equal to the width W of the opening part of the metal mask 20. On the contrary, at the end part of the substrate 31, the evaporation material scattered from the evaporation source 102 obliquely enters the substrate 31 through the opening part of the metal mask 20, so that the evaporation material is evaporated in a position shifted from the opening part of the meal mask 20 on the substrate 31 and the width W2 of the evaporated region is smaller as compared with the width W of the opening part of the metal mask 20. Thus, the deposition position is displaced, and the deposition area is varied depending upon the spot of the substrate 31.

[0022]

Especially, in order to attain high integration and high

resolution of the organic EL element, it is necessary to evaporate an organic light emitting layer having a designated area in a designated position on the patterned Hall injection electrode with high accuracy.

[0023]

When an evaporation source having the same area as the substrate is used, the organic light emitting material can be uniformly evaporated on a large-area substrate in a short time. In this case, however, the manufacturing device is increased in size, and the cost is increased with a large-amount consumption of evaporation material.

[0024]

It is an object of the invention to provide a manufacturing device and manufacturing method for an organic light emitting element capable of forming an evaporation layer on a substrate without displacement of the deposition position and variation of deposition area at a high deposition rate, keeping the uniformity of thickness of the film to be miniaturized and manufactured at a low cost.

[0025]

It is another object of the invention to provide an inexpensive organic light emitting element capable of attaining high integration and high resolution, and coloration.

[0026]

[Means for Solving the Problems and Advantage of the

Invention]

The manufacturing apparatus of the invention for an organic light emitting element is a manufacturing device for forming at least an organic material layer of an organic light emitting element where a first electrode, the organic material layer and a second electrode are stacked on a substrate by an evaporation method, characterized in that on one surface side of a shielding member having an opening part, an evaporation source is disposed in a position opposite to the opening part, and a moving mechanism for moving the substrate in a first direction relatively to the opening part is provided on the other side of the shielding member.

[0027]

In the manufacturing apparatus related to the invention, while the evaporation material scatted from an evaporation source is evaporated on a substrate through an opening part of a shielding member, the substrate is moved in a first direction relatively to the opening part by a moving mechanism so as to form an evaporation layer in a wide area on the substrate.

[0028]

In this case, since the evaporation material scattered from the evaporation source enters the substrate substantially vertically through the opening part of the shielding member, an evaporation layer with a uniform film thickness can be formed on the substrate even in the case of disposing the evaporation

source in a position near the substrate. Accordingly, the deposition rate can be improved by bringing the evaporation source close to the substrate so that throughput can be heightened by reduction of the deposition time.

[0029]

Further, even in the case of mounting a mask on the substrate, the evaporation material enters substantially vertically to the mask through the opening part of the shielding member not to cause displacement of the deposition position and variation in deposition area.

[0030]

Furthermore, since the evaporation source can be brought close to the substrate, the apparatus can be reduced in size. Further, it is not necessary to use a large-area evaporation source, so the cost can be lowered.

[0031]

The moving mechanism may be adapted to move the substrate relatively to the opening part by moving the substrate, or move the substrate relatively to the opening part by moving the shielding member.

[0032]

The evaporation source preferably has a width equal to or larger than the width of the evaporation region on the substrate in a second direction intersecting perpendicularly to the first direction. In this case, the evaporation material

scattered from the evaporation source enters substantially vertically overall in the cross direction of the evaporation region on the substrate. Accordingly, it is possible to form the evaporation layer having a uniform film thickness overall the evaporation region on the substrate.

[0033]

The evaporation source may be integrally provided in an area having a width equal to or larger than the width of the evaporation region on the substrate in a second direction. In this case, the evaporation material scattered from the single evaporation source can enter substantially vertically overall in the cross direction of the evaporation region on the substrate. Thus, the evaporation layer having a uniform film thickness can be formed overall in the evaporation region on the substrate.

[0034]

The evaporation source may be provided dispersively in an area having a width equal to or larger than the width of the evaporation region on the substrate in the second direction. In this case, the evaporation material scattered from one or more evaporation sources can enter substantially vertically overall in the cross direction of the evaporation region on the substrate. Thus, the evaporation layer having a uniform film thickness can be formed overall in the evaporation region on the substrate.

[0035]

The opening part of the shielding member may have a width equal to or larger than the width of the evaporation region on the substrate in the second direction intersecting perpendicularly to the first direction. In this case, the evaporation material scattered from the evaporation source can enter an area having the same width as the evaporation region on the substrate or an area having a larger area than the evaporation region through the opening part of the shielding member. Accordingly, the substrate is moved in the first direction relatively to the opening part of the shielding member, whereby the evaporation layer can be efficiently formed on the whole of the evaporation region on the substrate.

[0036]

The manufacturing method for an organic light emitting element according to the invention is a manufacturing method for forming at least an organic material layer of an organic light emitting element where a first electrode, the organic material layer and a second electrode are stacked on a substrate by an evaporation method, in which while on one surface side of a shielding member having an opening part, evaporation material is evaporated from an evaporation source disposed in a position opposite to the opening part, the substrate is moved in a first direction relatively to the opening part on the other surface side of the shielding member to thereby form an evaporation layer on the substrate.

[0037]

According to the manufacturing method of the invention, the evaporation material scattered from the evaporation source is evaporated on the substrate through the opening part of the shielding member, and simultaneously the substrate is moved in a first direction relatively to the opening part, thereby forming a wide-area evaporation layer on the substrate.

[0038]

In this case, the evaporation material scattered from the evaporation source enters the substrate substantially vertically through the opening part of the shielding member, so that even in the case of disposing the evaporation source in a position near the substrate, an evaporation layer having a uniform film thickness can be formed on the substrate. Accordingly, the deposition rate can be improved by bringing the evaporation source close to the substrate, and throughput can be heightened by reduction of the deposition time.

[0039]

Further, even in the case of mounting a mask on the substrate, the evaporation material scattered from the evaporation source enters the mask substantially vertically through the opening part of the shielding member, so that displacement of deposition position and variation of the deposition area will not be caused.

[0040]

Furthermore, the evaporation source can be brought close to the substrate, so the manufacturing apparatus can be reduced in size. Furthermore, it is not necessary to use a large-area evaporation source, so the cost can be lowered.

[0041]

The substrate may be moved relatively to the opening part by moving the substrate, or the substrate may be moved relatively to the opening part by moving the shielding member.

[0042]

Preferably the width of the evaporation source in a second direction intersecting perpendicularly to the first direction is set equal to or larger than the width of the evaporation region on the substrate. In this case, the evaporation material scattered from the evaporation source enters substantially vertically overall in the cross direction of the evaporation region on the substrate. Accordingly, the substrate is moved in the first direction relatively to the opening part of the shielding member, whereby an evaporation layer having a uniform film thickness can be formed overall the evaporation region on the substrate.

[0043]

The width of the shielding member in the second direction intersecting perpendicularly to the first direction may be set equal to or larger than the evaporation region on the substrate. In this case, the evaporation material scattered from the

evaporation source can enter an area having the same width as the evaporation region on the substrate or an area having a larger width than the evaporation region through the opening part of the shielding member. Accordingly, the substrate is moved in the first direction relatively to the opening part of the shielding member to thereby efficiently form the evaporation layer overall in the evaporation region on the substrate.

[0044]

In an organic light emitting element related to the invention, a first electrode, an organic material layer and a second electrode are stacked on a substrate, and the organic material layer is formed by evaporating evaporation material from an evaporation source disposed in a position opposite to an opening part on one surface side of a shielding member having the opening part and simultaneously moving the substrate relatively to the opening part on the other surface side of the shielding member.

[0045]

In the organic light emitting element of the invention, in forming the organic material layer, the evaporation material scattered from the evaporation source is evaporated on the substrate through the opening part of the shielding member, and simultaneously the substrate is moved relatively to the opening part of the shielding member, whereby the organic

material layer is formed on the first electrode on the substrate.

[0046]

In this case, the evaporation material scattered from the evaporation source enters the substrate substantially vertically through the opening part of the shielding member, so that even in the case of disposing the evaporation source in a position near the substrate, the organic material layer having a uniform film thickness can be formed on the first electrode on the substrate. Accordingly, the deposition rate can be improved by bringing the evaporation source close to the substrate, and throughput can be heightened by reduction of the deposition time.

[0047]

Further, even in the case of mounting a mask on the substrate, the evaporation material scattered from the evaporation source enters the mask substantially vertically through the opening part of the shielding member, so that displacement of deposition position of the organic material layer and variation of deposition area will not be caused.

[0048]

Furthermore, since the evaporation source can be brought close to the substrate, the manufacturing apparatus can be reduced in size. Furthermore, it is not necessary to use a large-area evaporation source, so the cost can be lowered.

[0049]

Accordingly, it is possible to obtain an inexpensive organic light emitting element which can attain high integration, high resolution and coloration.

[0050]

[Mode for Carrying Out the Invention]

Fig. 1 is a typical sectional view of a manufacturing device for an organic light emitting element according to one embodiment of the invention, and Fig. 2 is a typical perspective view of the manufacturing device of Fig. 1. This manufacturing device is used for manufacturing an organic electroluminescence element (hereinafter referred to as organic EL element for short).

[0051]

As shown in Fig. 1, a shielding plate 12 is disposed in a chamber 11 to be partitioned into an upper space and a lower space. An oblong evaporation window 13 is formed in the shielding plate 12. An evaporation source 16 is disposed opposite to the evaporation window 13 below the shielding plate 12. The evaporation source 16 is formed by an oblong heating holder 14 and an oblong evaporation material 15.

[0052]

A moving mechanism 17 for moving a substrate 1 in the direction of an arrow X (hereinafter referred to as transport direction X) and in the opposite direction thereto is provided on the shielding plate 12. The moving mechanism 17 is formed

by a pair of transport wires 18 and a pair of transport rollers 19. The paired transport wires 18 are stretched between the paired transport rollers 19. The substrate 1 is fitted to the paired transport wires 18.

[0053]

The metal mask 20 is fitted to the lower surface of the substrate 1 close to the substrate 1 at need. The interior of the chamber 11 is evacuated by an exhaust system (not shown).

[0054]

The length A of the evaporation window 13 in the direction parallel to the transport direction X and the length C of the evaporation material 15 of the evaporation source 16 are arbitrary. In the present embodiment, the length A of the evaporation window 13 and the length C of the evaporation material 15 are set equal to each other.

[0055]

As shown in Fig. 2, the width B of the evaporation window 13 in the direction intersecting perpendicularly to the transport direction X is set equal to or larger than the width E of the substrate 1. The width D of the evaporation material 15 of the evaporation source 16 in the direction intersecting perpendicularly to the transport direction X is also set equal to or larger than the width E of the substrate 1.

[0056]

In the present embodiment, the length A of the evaporation

window 13 is 5 cm, and the width B is 30 cm. The length C of the evaporation material 15 of the evaporation source 16 is 5 cm, and the width D is 30 cm. The distance between the substrate 1 and the evaporation source 16 is set to 20 cm, for example.

[0057]

In the manufacturing apparatus of the present embodiment, while the evaporation material scattered from the evaporation source 16 is evaporated on the substrate 1 through the evaporation window 13 of the shielding plate 12, the substrate 1 is transported in the transport direction X by the moving mechanism 17, thereby forming an evaporation layer in a large area of the substrate 1.

[0058]

In this case, the evaporation material scattered from the evaporation source 16 enters the substrate 1 substantially vertically through the evaporation window 13 of the shielding plate 12, so that even in the case of disposing the evaporation source 16 in a position near the substrate 1, an evaporation layer having a uniform film thickness can be formed on the substrate 1. Accordingly, the deposition rate can be improved by bringing the evaporation source 16 close to the substrate 1, and throughput can be heightened by reduction of deposition time.

[0059]

Even in the case of mounting a metal mask 20 on the substrate

1, the evaporation material scatted from the evaporation source 16 enters the metal mask 20 through the evaporation window 13 of the shielding plate 12, so that displacement of the deposition position and variation of deposition area will not be caused.

[0060]

Furthermore, since the evaporation source 16 can be brought close to the substrate 1, the manufacturing apparatus can be reduced in size. Thus, the interior of the chamber 11 can be evacuated in a short time, so that the manufacturing time can be shortened. Since it is not necessary to use the large-area evaporation source, the cost can be lowered.

[0061]

Figs. 3, 4 and 5 are sectional views of processes showing a manufacturing method for an organic EL element according to one embodiment of the invention.

[0062]

In Fig. 3A, a glass substrate 300 mm x 300 mm is used as a substrate 1. A transparent conductive film having a film thickness of 0.2 μm and made of ITO is formed on the substrate 1 by a sputtering process. After that, resist is applied onto the transparent conductive film, and pre-bake (pre-exposure bake) is performed, then the resist is exposed to light in a designated pattern and development is performed. After development, post-bake (post-development bake) is performed, and the substrate 1 is immersed in a ferric chloride solution

to perform etching. After the end of etching, the resist is separated. Thus, a Hall injection electrode 2 made of the transparent conductive film is formed on the substrate 1.

[0063]

Subsequently, after the substrate 1 is washed, resist is applied on the substrate 1 where the Hall injection electrode 2 is formed, pre-bake is performed, then the resist is exposed to light in a designated pattern, and development is performed. After development, post-bake is performed, and further baking is performed at 200°C in a vacuum with 5 Torr for two hours to cure and alter the resist. Thus, as shown in Fig. 3B, an insulating layer 3 made of resist is formed on the Hall injection electrode 2.

[0064]

Although baking at 200°C in a vacuum is performed for curing and altering the resist in the present embodiment, this is not restrictive, but a method of baking in an atmosphere of nitrogen while performing ultraviolet irradiation and a method of baking in a vacuum atmosphere while performing ultraviolet irradiation (both are called UV (ultraviolet) curing) may be used. Further, baking may be performed at a temperature equal to or higher than 180°C in an atmosphere of nitrogen.

[0065]

Subsequently, resist is applied to the surfaces of the

insulating layers 3 and the Hall injection electrode 2, pre-bake is performed, then the resist is exposed to light in a designated pattern, and development is performed. Thus, as shown in Fig. 3C, a bulkhead separation layer 4 made of resist is formed on the insulating layer 3.

[0066]

In this case, in order to cause a stepped cut in a Hall injection layer, a Hall transport layer, an electron transport layer, an electron injection electrode and a protective film formed in the following processes, reverse tapered resist is used, and the film thickness of the resist is made larger than the total film thickness of the Hall injection layer, the Hall transport layer, the electron transport layer, the electron injection electrode and the protective film. Thus, a high step is formed. In the present embodiment, the total film thickness of the Hall injection layer, the Hall transport layer, the electron transport layer, the electron injection electrode and the protective film is set about 0.6 μm, and the film thickness of the bulkhead separation layer 4 is set to 4 μm.

[0067]

Subsequently, the substrate 1 where the bulkhead separation layers 4 are formed is fitted to the transport wires 18 of the manufacturing apparatus shown in Figs. 1 and 2, and Hall injection material as the evaporation material 15 of the evaporation source 16 is set in the heating holder 14. As the

Hall injection material, used is CuPc (Copper (II) phthalocyanine). After the interior of the chamber 11 is evacuated to a designated degree of vacuum, the substrate 1 is transported in the transport direction X by the moving mechanism 17 and simultaneously the Hall injection material is evaporated from the evaporation source 16 on the substrate 1 to thereby form the Hall injection layer 5 on the Hall injection electrode 2, the insulating layer 3 and the bulkhead separation layer 4 as shown in Fig. 3D.

[0068]

Subsequently, the evaporation material 15 of the evaporation source 16 is replaced with Hall transport material. As the Hall transport material, used is NPB (N,N'-Di(naphthalene-1-yl)-N,N'-Di(phenyl-benzidine). After the interior of the chamber 11 is evacuated to a designated degree of vacuum, the substrate 1 is transported in the transport direction X by the moving mechanism 17 and simultaneously the Hall transport material is evaporated from the evaporation source 16 on the substrate 1 to thereby form a Hall transport layer 6 on the Hall injection layer 5 as shown in Fig. 3D.

[0069]

After that, the substrate 1 is taken out of the manufacturing apparatus, and as shown in Fig. 4E, a first metal mask 20a is positioned to the substrate 1 and set. The first metal mask 20a has an opening part in a position corresponding

to an area of a red light emitting element. The substrate 1 where the first metal mask 20a is set is fitted to the transport wires 18 of the manufacturing apparatus.

[0070]

The evaporation material 15 of the evaporation source 16 is replaced with an electronic transport material to which red light emitting material is added. In the present embodiment, $Alq_3$ (Tris(8-quinolinolato)aluminum) is taken as host (electron transport material), and 5 wt.% AD688, which is a red light emitting laser coloring matter, is doped.

[0071]

After the interior of the chamber 11 is evacuated to a designated degree of vacuum, the substrate 1 is transported in the transport direction X by the moving mechanism 17 and simultaneously the electron transport material is evaporated from the evaporation source 16 on the substrate 1 through the first metal mask 20a to thereby form an electron transport layer 7a emitting light in red on the Hall transport layer 6.

[0072]

Subsequently, the substrate 1 is taken out of the manufacturing apparatus, and as shown in Fig. 4F, a second metal mask 20b is positioned to the substrate 1 and set in place of the first metal mask 20a. The second metal mask 20b has an opening part in a position corresponding to an area of a blue light emitting element. The substrate 1 where the second metal

mask 20b is set is fitted to the transport wires 18 of the manufacturing apparatus.

[0073]

Further, the evaporation material 15 of the evaporation source 16 is replaced with an electron transport material to which blue light emitting material is added. In the present embodiment, Balq ((1,1'-bisphenyl)-(4-olaio)bis(2-methyl-8-quinolinolate-N1, 08)Aluminum) is taken as a host (electron transport material), and 2.5 wt.% perylene, which is a blue light emitting fluorescent coloring matter, is doped.

[0074]

After the interior of the chamber 11 is evacuated to a designated degree of vacuum, the substrate 1 is transported in the transport direction X by the moving mechanism 17 and simultaneously the electron transport material is evaporated from the evaporation source 16 on the substrate 1 through the second metal mask 20b to thereby form an electron transport layer 7b emitting light in blue on the Hall transport layer 6.

[0075]

Subsequently, the substrate 1 is taken out of the manufacturing apparatus, and as shown in Fig. 4G, a third metal mask 20c is positioned to the substrate 1 and set in place of the second metal mask 20b. The third metal mask 20c has an

opening part in a position corresponding to an area of a green light emitting element. The substrate 1 where the third metal mask 20c is set is fitted to the transport wires 18 of the manufacturing apparatus.

[0076]

Further, the evaporation material 15 of the evaporation source 16 is replaced with an electron transport material to which a green light emitting material is added. In the present embodiment, $Alq_3$, which is a green light emitting material, is used as an electron transport material.

[0077]

After the interior of the chamber 11 is evacuated to a designated degree of vacuum, the substrate 1 is transported in the transport direction X by the moving mechanism 17 and simultaneously the electron transport material is evaporated from the evaporation source 16 on the substrate 1 through the third metal mask 20c to thereby form an electron transport layer 7c emitting light in green on the Hall transport layer 6.

[0078]

After that, the third metal mask 20c is removed from the substrate 1, and the evaporation material 15 of the evaporation source 16 is replaced with an electrode material. As the electrode material, MgIn is used. After the interior of the chamber 11 is evacuated to a designated degree of vacuum, the substrate 1 is transported in the transport direction X by the

moving mechanism 17 and simultaneously the electrode material is evaporated on the substrate 1 from the evaporation source 16 to thereby form electron injection electrodes 8 on the electron transport layers 7a, 7b, 7c.

[0079]

Further, the evaporation material 15 of the evaporation source 16 is replaced with the material for a protective film to thereby form a protective film 9 on the electron injection electrode 8. In the present embodiment, as the protective film 9, SiO is used. Thus, the red light emitting element, the blue light emitting element and the green light emitting element are formed on the substrate 1.

[0080]

Lastly, as shown in Fig. 5J, the one or more light emitting elements on the substrate 1 are sealed with a sealing compound 10. In this case, the organic light emitting materials such as the Hall injection material, the Hall transport material and the electron transport material are liable to soak up moisture, and when they contain moisture, the luminous intensity is easily deteriorated, so sealing is performed in an atmosphere of dry nitrogen.

[0081]

Through the above processes, a full-color organic EL element is manufactured, in which the red, blue and green light emitting elements are disposed on the substrate 1.

[0082]

The change in evaporation speed of the Hall injection material, the Hall transport material and the electron transport material in the case of varying the distance between the substrate and the evaporation source in the manufacturing apparatus shown in Figs. 1 and 2 has been measured. The measurement results are shown in Fig. 6. In this arrangement, the length A in the transport direction X of the evaporation window 13 of the shielding plate 12 is set to 5 cm, and the width B in the direction intersecting perpendicularly to the transport direction X is set to 30 cm.

[0083]

As shown in Fig. 6, with decrease in the distance between the substrate 1 and the evaporation source 16, the evaporation speed is increased. When the distance between the substrate 1 and the evaporation source 16 is set to 20cm, for example, the evaporation speed of the Hall injection material is 22Å/sec, the evaporation speed of the Hall transport material is 55Å/sec and the evaporation speed of the electron transport material is 76Å/sec.

[0084]

Further, in the manufacturing apparatus shown in Figs. 1 and 2, the length of the evaporation window of the shielding plate is varied to measure the change in the evaporation speed. The measurement results are shown in Fig. 7. In this measurement,

the length A in the transport direction X of the evaporation window 13 of the shielding plate 12 is varied to 1 cm, 5 cm and 8 cm, and the width B in the direction intersecting perpendicularly to the transport direction X is set to 30 cm. As the evaporation material 15, Hall injection material is used.

[0085]

As shown in Fig. 7, with increase in length A of the evaporation window 13, the evaporation speed is increased. In the case where the distance between the substrate 1 and the evaporation source 16 is set to 20 cm, for example, when the length A of the evaporation window 13 is set to 1 cm, the evaporation speed is 7Å/sec, when the length A of the evaporation window 13 is set to 5 cm, the evaporation speed is 22Å/sec, and when the length A of the evaporation window 13 is set to 8cm, the evaporation speed is 46Å/sec.

[0086]

According to the result shown in Fig. 7, when the length A of the evaporation window 13 of the shielding plate 12 is set to 5 cm, the evaporation speed is 22Å/sec, so that the Hall injection material is deposited 100Å in about 4.6 sec. Accordingly, in the process of Fig. 3D, in the case of forming a Hall injection layer 5 having a film thickness of 100Å, the transport speed of the substrate 1 by the moving mechanism 17 is set to 11mm/sec so that the substrate 1 is moved 5 cm in about 4.6 second.

[0087]

In the case of forming the Hall injection layer 5, the Hall transport layer 6, the electron transport layers 7a, 7b, 7c, the electron injection electrode 8 and the protective film 9 of the organic EL element by the manufacturing apparatus shown in Figs. 1 and 2 as described above, a uniform film thickness can be secured.

[0088]

In the case of forming the electron transport layers 7a, 7b, 7c with the metal masks 20a, 20b, 20c set on the substrate 1, the evaporation material scattered from the evaporation source 16 enters the metal masks 20a, 20b, 20c substantially vertically through the evaporation window 13 of the shielding plate 12, so that displacement of deposition position and variation of deposition area will not be caused.

[0089]

Furthermore, the evaporation source 16 can be brought close to the substrate 1 so as to improve the deposition rate of the evaporation layer and shorten the deposition time. Further, since the chamber 11 is reduced in size, the interior of the chamber 11 can be evacuated in a short time so as to shorten the manufacturing time. As a result, throughput can be heightened.

[0090]

As it is not necessary to use an evaporation source having

a large area, the cost can be lowered.

[0091]

Accordingly, it is possible to obtain an inexpensive organic EL element which can attain high integration, high resolution and full-coloration.

[0092]

Fig. 8 is a typical perspective view of a manufacturing apparatus for an organic light emitting element according to another embodiment of the invention.

[0093]

In the manufacturing apparatus of Fig. 8, one or more evaporation sources 16a are disposed below an evaporation window 13 of a shielding plate 12. The evaporation sources 16a are respectively formed by an oblong heating holder 14a and an oblong evaporation material 15a. The one or more evaporation sources 16a are dispersively disposed in an area opposite to the evaporation window 13 of the shielding plate 12. In the present embodiment, one or more evaporation sources 16a are arranged along the direction intersecting perpendicularly to the transport direction X.

[0094]

In the present embodiment, the length C of the area for arranging the one or more evaporation sources 16a is set equal to the length A of the evaporation window 13. The width D of the area for arranging the one or more evaporation sources 16a

is set substantially equal to the width B of the evaporation window 13. The constitution of the other parts of the manufacturing apparatus of Fig. 8 is similar to that of the manufacturing apparatus shown in Figs. 1 and 2.

[0095]

In the manufacturing apparatus of the present embodiment, while the evaporation material scattered from the one or more evaporation sources 16a is evaporated on the substrate 1 through the evaporation window 13 of the shielding plate 12, the substrate 1 is moved in the transport direction X to the evaporation window 13 by the moving mechanism 17 to form the evaporation layer in a wide area of the substrate 1.

[0096]

In this case, the evaporation material scattered from the one or more evaporation sources 16a enters the substrate 1 substantially vertically through the evaporation window 13 of the shielding plate 12, so that even in the case of disposing the plurality of evaporation sources 16a in a position close to the substrate 1, the evaporation layer having a uniform film thickness can be formed on the substrate 1. Accordingly, the deposition rate can be improved by bringing the plurality of evaporation sources 16a close to the substrate, so that throughput can be heightened by reduction of the deposition time.

[0097]

Further, even in the case of setting the metal mask 20 on the substrate 1, the evaporation material scattered from the plurality of evaporation sources 16a enters the metal mask 20 substantially vertically through the evaporation window 13 of the shielding plate 12, so that displacement of the deposition position and variation of the deposition area will not be caused.

[0098]

Furthermore, the manufacturing apparatus can be reduced in size by bringing the evaporation source 16a close to the substrate 1. Accordingly, the interior of the chamber can be evacuated in a short time so as to shorten the manufacturing time. Since it is not necessary to use a large-area evaporation source, the cost can be lowered.

[0099]

Although the substrate 1 is moved by the moving mechanism 17 to thereby move the substrate 1 relatively to the evaporation window 13 in the above embodiment, the substrate 1 may be moved relatively to the evaporation window 13 by moving the shielding plate 12.

[0100]

Although the width B of the evaporation window 13 of the shielding plate 12 and the width D of the evaporation material 15 of the evaporation source 16 are set larger than the width of the substrate 1 in the above embodiment, in the case of evaporating in a partial region on the substrate 1, the width

B of the evaporation window 13 of the shielding plate 12 and the width D of the evaporation material 15 of the evaporation source 16 may be set equal to or larger than the width of the evaporation region and smaller than the width E of the substrate 1.

[Brief Description of the Drawings]

Fig. 1 is a typical sectional view of a manufacturing apparatus for an organic light emitting element according to one embodiment of the invention;

Fig. 2 is a typical perspective view of the manufacturing apparatus shown in Fig. 1:

Figs. 3A to 3D are sectional views of the processes showing a manufacturing method for an organic EL element using the manufacturing apparatus of Fig. 1;

Figs. 4E to 4G are sectional view of the processes showing the manufacturing method for an organic EL element using the manufacturing apparatus of Fig. 1;

Figs 5H and 5I are sectional views of the processes showing the manufacturing method for an organic EL element using the manufacturing apparatus of Fig. 1;

Figs. 6 is a diagram showing the result of measurement on the change in evaporation speed of Hall injection material, Hall transport material and electron transport material in the case of varying the distance between the substrate and the

evaporation source in the manufacturing apparatus of Fig. 1;

Fig. 7 is a diagram showing the result of measurement on the change in evaporation speed in the case of varying the length of the evaporation window of the shielding plate in the manufacturing apparatus of Fig. 1;

Fig. 8 is a typical perspective view of a manufacturing apparatus for an organic light emitting element according to another embodiment of the invention;

Figs. 9A to 9D are sectional views of the processes showing a manufacturing method for an organic EL element;

Figs. 10E to 10G are sectional views of the processes showing the manufacturing method for the organic EL element;

Fig. 11 is a typical sectional view showing the conventional manufacturing apparatus for an organic light emitting element; and

Fig. 12 is a diagram showing the position relationship of an evaporation source, a substrate and metal masks in the case of separately applying organic light emitting materials in a full-color organic EL element.

[Description of the Reference Numerals and Signs]

1: substrate 2: Hall injection electrode 3: insulating layer 4: bulkhead separation layer 5: Hall injection layer 6: Hall transport layer 7a, 7b, 7c: electron transport layer 8: electron injection electrode 9: protective film 10: sealing compound 11: chamber 12: shielding plate 13:

evaporation window 14, 14a: heating holder 15, 15a: evaporation material 16, 16a: evaporation source 17: moving mechanism 18: transport wire 19: transport roller 20, 20a, 20b, 20c: metal mask

FIGURE 6:

EVAPORATION SPEED (A/sec)

SUBSTRATE-EVAPORATION SOURCE DISTANCE (cm)

●: ELECTRON TRANSPORT MATERIAL ○: HALL TRANSPORT MATERIAL

△: HALL INJECTION MATERIAL

FIGURE 7:

EVAPORATION SPEED (A/sec)

SUBSTRATE-EVAPORATION SOURCE DISTANCE (cm)

●: LENGTH A OF EVAPORATION WINDOW: 8cm ○: LENGTH A OF EVAPORATION CHAMBER: 5cm △: LENGTH A OF EVAPORATION WINDOW: 1 cm